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Cognitive development

Cognitive development is a field of study in neuroscience and psychology focusing on a child's .development in terms of information processing, conceptual resources, perceptual skill, language learning, and other aspects of brain development and cognitive psychology compared to an adult's

point of view. In other words, cognitive development is the emergence of the ability to think and understand.[1] A large portion of research has gone into understanding how a child imagines the world. Jean Piaget was a major force in the establishment of this field, forming his "theory of cognitive development". Piaget proposed four stages of cognitive development: the *sensorimotor*, *preoperational*, *concrete operational* and *formal operational* period.[2] Many of his theoretical claims have since fallen out of favor. However, his description of the more

prominent changes in cognition with age (e.g., that it moves from being dependent on actions and perception in infancy to an understanding of the more observable aspects of reality in childhood to capturing the underlying abstract rules and principles in adolescence) is generally still accepted today. Perhaps equally importantly, Piaget identified and described many cognitive changes that must be explained, such as object permanence in infancy and the understanding of logical relations and cause-effect reasoning in school age children. The many phenomena he

described still attract the interest of many current researchers.

In recent years however, alternative models have been advanced, including information-processing theory, neo-Piagetian theories of cognitive development, which aim to integrate Piaget's ideas with more recent models and concepts in developmental and cognitive science, theoretical cognitive neuroscience, and social-constructivist approaches.

A major controversy in cognitive development has been "nature versus nurture", that is, the question if

cognitive development is mainly determined by an individual's innate qualities ("nature"), or by their personal experiences ("nurture"). However, it is now recognized by most experts that this is a false dichotomy: there is overwhelming evidence from biological and behavioral sciences that from the earliest points in development, gene activity interacts with events and experiences in the environment.[3]

Cognitive development and motor development may also be closely interrelated. When a person

experience a neurodevelopmental disorder and their cognitive development is disturbed, we often see adverse effects in motor development as well. Cerebellum, which is the part of brain that is most responsible for motor skills, has been shown to have significant importance in cognitive functions in the same way that prefrontal cortex has important duties in not only cognitive abilities but also development of motor skills. To support this, there is evidence of close co-activation of neocerebellum and dorsolateral prefrontal cortex in functional neuroimaging as well as

abnormalities seen in both cerebellum and prefrontal cortex in the same developmental disorder. In this way, we see close interrelation of motor development and cognitive development and they cannot operate in their full capacity when either of them are impaired or delayed. [4]

Historical origins: The history and theory of cognitive development.

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Jean Piaget is
inexorably linked to
cognitive development.
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It is clear that in Piaget's writings that there are influences from many historical predecessors. A few that are worth mentioning are included in the following Historical Origins chart. It is intended to be a more inclusive list of researchers who have studied the processes of acquiring more complex ways of thinking as people grow and develop:

	DOB/Death	Contribution to Cognitive Development
Jean-Jacques Rousseau	1712-1778	Wrote *Emile, or On Education*,[5] (1762). He discusses childhood development as happening in three stages. First stage, up to age 12, the child is guided by their emotions and impulses. The second stage, ages 12–16, the child's reason starts to develop. The third and final stage, age 16 and up, the child develops into an adult.
James Sully	1842-1923	Wrote several books on childhood development, including "*Studies of Childhood*[6]*" (1895) and "*Children's Ways[7]" (1897). He used a detailed observational study method with the children. Contemporary research in child development actually repeats observations, and observational methods, summarized by Sully in his 1895 work *"Studies of Childhood",* such as the mirror technique.
Lev Vygotsky	1896-1934	Area of specialty was developmental psychology. Main contribution is the somewhat controversial "Zone of Proximal Development" (ZPD) which states that 'play' of young children should be their main activity as this is their main source of development in terms of emotional, volitional, and cognitive development. ZPD is the link between children's learning and cognitive development.
Maria Montessori	1870-1952	Began her career working with mentally disabled children in 1897, then she conducted observation and experimental research in elementary schools. Wrote *The Discovery of the Child*[8] (1948). Discussed the Four Planes of Development. Birth - 6, 6 -12, 12 -18, and 18 -24. The Montessori Method now has three developmentally-meaningful age groups. 2 - 2.5, 2.5 - 6, and 6 - 12. She was working on human behavior in older children but only published lecture notes on the subject.
Jean	1896-1980	Piaget was the first psychologist and philosopher to brand this type of study as "cognitive development". Other researchers, in multiple disciplines, had studied development in children before, but Piaget is often credited as being the first one to make a systematic study of

Piaget		cognitive development and gave it its name. His main contribution is the stage theory of child cognitive development. He also published his observational studies of cognition in children, and created a series of simple tests to reveal different cognitive abilities in children.
Lawrence Kohlberg	1927-1987	Wrote the theory of stages of moral development which extended Piaget's findings of cognitive development and showed that they continue through the lifespan. Kohlberg's 6 stages follow Piaget's constructivist requirements in that stages can not be skipped and it is very rare to regress in stages. Notable works: *Moral Stages and Moralization: The Cognitive-Development Approach*[9] (1976) and *Essays on Moral Development*[10] (1981)

Piaget's theory of cognitive development

Jean Piaget (1896–1980) believed that people move through stages of development that allow them to think in new, more complex ways.

Sensorimotor stage

The first stage in Piaget's stages of cognitive development is the sensorimotor stage. This stage lasts from birth to two years old. During this stage, behaviors lack a sense of thought and logic. Behaviors gradually move from acting upon inherited reflexes to interacting with the environment with a goal in mind and being able to represent the external world at the end.

The sensorimotor stage has been broken down into six sub stages that explain the gradual development of infants from birth to age 2. Once the

child gains the ability to mentally represent reality, the child begins the transition to the preoperational stage of development.[11]

Birth to one month

Each child is born with inherited reflexes that they use to gain knowledge and understanding about their environment. *Examples of these reflexes include grasping and sucking.*[12]

1–4 months

Children repeat behaviors that happen unexpectedly because of their reflexes. *For example, a child's finger comes in contact with the mouth and the child starts sucking on it. If the sensation is pleasurable to the child, then the child will attempt to recreate the behavior.*[12] Infants use their initial reflexes (grasping and sucking) to explore their environment and create schemes. Schemes are groups of similar actions or thoughts that are used repeatedly in response to the environment.[13] Once a child begins to create schemes they use accommodation and assimilation to

become progressively adapted to the world.[14] **Assimilation** is when a child responds to a new event in a way that is consistent with an existing schema. *For example, an infant may assimilate a new teddy bear into their putting things in their mouth scheme and use their reflexes to make the teddy bear go into their mouth.*[13]

Accommodation is when a child either modifies an existing scheme or forms an entirely new schema to deal with a new object or event. *For example, an infant may have to open his or her mouth wider than usual to accommodate the teddy bear's*

paw.[13]

5–8 months

Child has an experience with an external stimulus that they find pleasurable, so they try to recreate that experience. *For example, a child accidentally hits the mobile above the crib and likes to watch it spin. When it stops the child begins to grab at the object to make it spin again.* In this stage habits are formed from general schemes that the infant has created but there is not yet, from the child's point of view, any differentiation

between means and ends.[15] Children cannot also focus on multiple tasks at once, and only focus on the task at hand.[13] The child may create a habit of spinning the mobile in its crib, but they are still trying to find out methods to reach the mobile in order to get it to spin in the way that they find pleasurable. Once there is another distraction (say the parent walks in the room) the baby will no longer focus on the mobile. Toys should be given to infants that respond to a child's actions to help foster their investigative instincts.[16] *For example, a toy plays a song when*

you push one button, and then a picture pops up if you push another button.

8–12 months

Behaviors will be displayed for a reason rather than by chance. They begin to understand that one action can cause a reaction.[12] They also begin to understand **object permanence**, which is the realization that objects continue to exist when removed form view. *For example: The baby wants a rattle but the blanket is in the way. The baby moves the*

blanket to get the rattle. Now that the infant can understand that the object still exists, they can differentiate between the object, and the experience of the object. According to psychologist David Elkind, "An internal representation of the absent object is the earliest manifestation of the symbolic function which develops gradually during the second year of life whose activities dominate the next stage of mental growth."[17]

12–18 months

Actions occur deliberately with some

variation. *For example a baby drums on a pot with a wooden spoon, then drums on the floor, then on the table.*[12]

18–24 months

Children begin to build mental symbols and start to participate in pretend play. *For example, a child is mixing ingredients together but doesn't have a spoon so they pretend to use one or use another object the replace the spoon.*[12] **Symbolic thought** is a representation of objects and events as mental entities or

symbols which helps foster cognitive development and the formation of imagination.[18] According to Piaget, the infant begins to act upon intelligence rather than habit at this point. The end product is established after the infant has pursued for the appropriate means. The means are formed from the schemes that are known by the child.[15] The child is starting to learn how to use what it has learned in the first two years to develop and further explore their environment.

Preoperational stage

Lasts from 2 years of age until 6 or 7. It can be characterized in two somewhat different ways. In his early work, before he had developed his structuralist theory of cognition, Piaget described the child's thought during this period as being governed by principles such as egocentrism, animism and other similar constructs. Egocentrism is when a child can only see a certain situation his or her own way. One can not comprehend that other people have other views and perceptions of scenarios. Animism is when an individual gives a lifeless

object human like qualities. An individual usually believes that this object has human emotions, thoughts and intentions. Once he had proposed his structuralist theory, Piaget characterized the preoperational child as lacking the cognitive structures possessed by the concrete operational child. The absence of these structures explains, in part, the behaviors Piaget had previously described as egocentric and animistic, for example an inability to comprehend that another individual may have different emotional responses to similar

experiences.[11][19] During this stage children also become increasingly adept at using symbols as evidenced by the increase in playing and pretending.

Concrete operational stage

Lasts from 6 or 7 years until about 12 or 13. During this stage the child's cognitive structures can be characterized by reality. Piaget argues that the same general principles can be discerned in a wide range of behaviors. One of the best-known achievements of this stage is that of

conservation. In a typical conservation experiment a child is asked to judge whether or not two quantities are the same – such as two equal quantities of liquid in a short and tall glass. A preoperational child will typically judge the taller, thinner glass to contain more, while a concrete operational child will judge the amounts still to be the same. The ability to reason in this way reflects the development of a principle of conservation.[11]

Formal operational stage

Lasts from 12 or 13 until adulthood and are advancing from logical reasoning with concrete examples to abstract examples. The need for concrete examples is no longer necessary because abstract thinking can be used instead. In this stage adolescents are also able to view themselves in the future and can picture the ideal life they would like to pursue. Some theorists believe the formal operational stage can be divided into two sub-categories: early formal operational and late formal operation thought. Early formal operational thoughts may be just

fantasies, but as adolescents advance to late formal operational thought the life experiences they have encountered changes those fantasy thoughts to realistic thoughts.[11]

Criticism

Many of his claims have fallen out of favor. For example, he claimed that young children cannot conserve numbers. However, further experiments showed that children did not really understand what was being asked of them. When the experiment is done with candies, and the children

are asked which set they *want* rather than having to tell an adult which is more, they show no confusion about which group has more items.

Other theoretical perspectives on cognitive development

Speculated core systems of cognition

Empiricists study how these skills may be learned in such a short time. The debate is over whether these systems are learned by general-purpose learning devices, or domain-

specific cognition. Moreover, many modern cognitive developmental psychologists, recognizing that the term "innate" does not square with modern knowledge about epigenesis, neurobiological development, or learning, favor a non-nativist framework. Researchers who discuss "core systems" often speculate about differences in thinking and learning between proposed domains. Researchers who posit a set of so-called "core domains" suggest that children have innate sensitivity to specific kinds of patterns of information. Those commonly cited

include:

Number

Infants appear to have two systems for dealing with numbers. One deals with small numbers, often called subitizing. Another deals with larger numbers in an approximate fashion.[20]

Space

Very young children appear to have some skill in navigation. This basic ability to infer the direction and

distance of unseen locations develops in ways that are not entirely clear. However, there is some evidence that it involves the development of complex language skills between 3 and 5 years.[21] Also, there is evidence that this skill depends importantly on visual experience, because congenitally blind individuals have been found to have impaired abilities to infer new paths between familiar locations.

Visual perception

One of the original nativist versus

empiricist debates was over depth perception. There is some evidence that children less than 72 hours old can perceive such complex things as biological motion.[22] However, it is unclear how visual experience in the first few days contributes to this perception. There are far more elaborate aspects of visual perception that develop during infancy and beyond.

Essentialism

Young children seem to be predisposed to think of biological

entities (e.g., animals and plants) in an essentialistic way.[23] This means that they expect such entities (as opposed to, e.g., artifacts) to have many traits such as internal properties that are caused by some "essence" (such as, in our modern Western conceptual framework, the genome).

Language acquisition

A major, well-studied process and consequence of cognitive development is language acquisition. The traditional view was that this is

the result of deterministic, human-specific genetic structures and processes. Other traditions, however, have emphasized the role of social experience in language learning. However, the relation of gene activity, experience, and language development is now recognized as incredibly complex and difficult to specify. Language development is sometimes separated into learning of phonology (systematic organization of sounds), morphology (structure of linguistic units—root words, affixes, parts of speech, intonation, etc.), syntax (rules of grammar within

sentence structure), semantics (study of meaning), and discourse or pragmatics (relation between sentences). However, all of these aspects of language knowledge—which were originally posited by the linguist Noam Chomsky to be autonomous or separate—are now recognized to interact in complex ways.

Bilingualism

It wasn't until recently that bilingualism had really been accepted as a contributing factor to cognitive

development. Ellen Bialystok, was, and is a big game changer in this field. Bialystok has done years of research on the effects bilingualism has on cognitive development. There have been a number of studies showing how bilingualism contributes to the executive function of the brain, which is the main center at which cognitive development happens.According Bialystok in “Bilingualism and the Development of Executive Function: The Role of Attention”, children who are bilingual, have to actively filter through the two different languages to select the one

they need to use, which in turn makes the development stronger in that center.[24]

Whorf's hypothesis

Benjamin Whorf (1897 – 1941), while working as a student of Edward Sapir, posited that a person's thinking depends on the structure and content of their social group's language. In other words, it is the belief that language determines our thoughts and perceptions. For example, it used to be thought that Greeks, who wrote left to right, thought differently than

Egyptians since the Egyptians wrote right to left. Whorf's theory was so strict that he believed if a word is absent in a language, then the individual is unaware of the object's existence.[25] This theory was played out in George Orwell's book, Animal Farm; the pig leaders slowly eliminated words from the citizen's vocabulary so that they were incapable of realizing what they were missing.[26] The Whorfian hypothesis failed to recognize that people can still be aware of the concept or item, even though they lack efficient coding to quickly identify the target

information.[25]

Quine's bootstrapping hypothesis

Willard Van Orman Quine (1908-2000) argued that there are innate conceptual biases that enable the acquisition of language, concepts, and beliefs. Quine's theory follows nativist philosophical traditions, such as the European rationalist philosophers, for example Immanuel Kant.

Neo-Piagetian theories of cognitive development

Neo-Piagetian theories of cognitive development emphasized the role of information processing mechanisms in cognitive development, such as attention control and working memory. They suggested that progression along Piagetian stages or other levels of cognitive development is a function of strengthening of control mechanisms and enhancement of working memory storage capacity.

Neuroscience

During development, especially the

first few years of life, children show interesting patterns of neural development and a high degree of neuroplasticity. Neuroplasticity, as explained by The World Health Organization, can be summed in three points. 1.) Any adaptive mechanism used by the nervous system to repair itself after injury. 2.) Any means by which the nervous system can repair individually damaged central circuits. 3.) Any means by which the capacity of the central nervous system can adapt to new physiological conditions and environment. The relation of brain development and cognitive

development is extremely complex and, since the 1990s, has been a growing area of research.

Cultural influences

From cultural psychologists' view, minds and culture shape each other. In other words, culture can influence brain structures which then influence our interpretation of the culture. These examples reveal cultural variations in neural responses:

Figure-line task (Hedden et al., 2008)

Behavioral research has shown that one's strength in independent or interdependent tasks differ based on their cultural context. In general, East Asian cultures are more interdependent whereas Western cultures are more independent. Hedden et al. assessed functional magnetic resonance imaging (fMRI) responses of East Asians and Americans while they performed independent (absolute) or interdependent (relative) tasks. The study showed that participants used regions of the brain associated with attentional control when they had to

perform culturally incongruent tasks. In other words, neural paths used for the same task were different for Americans and East Asians (Hedden et al., 2008).[27]

Kobayashi et al., 2007

Kobayashi et al. compared American-English monolingual and Japanese-English bilingual children's brain responses in understanding others' intentions through false-belief story and cartoon tasks. They found universal activation of the region bilateral ventromedial prefrontal

cortex in theory of mind tasks. However, American children showed greater activity in the left inferior frontal gyrus during the tasks whereas Japanese children had greater activity in right inferior frontal gyrus during the Japanese Theory of Mind tasks. In conclusion, these examples suggest that the brain's neural activities are not universal but are culture dependent.[28]

See also

- Reuven Feuerstein
- Developmental psychology

- Child development stages
- Infant cognitive development
- Human behavior genetics

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